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DeYaeger

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(54) **SYSTEM AND METHOD FOR VERIFYING SCREW THREADS**

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(51) **Int. Cl.**

G01B 3/48	(2006.01)
G01L 5/00	(2006.01)
G01B 3/36	(2006.01)

(52) **U.S. Cl.**

CPC .. ***G01B 3/36*** (2013.01); ***G01B 3/48*** (2013.01); ***G01L 5/0042*** (2013.01)

(58) **Field of Classification Search**

CPC G01B 3/36; G01B 3/48; G01L 5/0042
USPC ..... 33/199 R
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,861,347	A *	11/1958	Tarnik	33/501.45
3,814,934	A	6/1974	Mesh et al.	
4,562,722	A *	1/1986	Schuele et al.	73/11.01
4,693,196	A	9/1987	Hager	
4,926,700	A	5/1990	Peplinski	
5,018,465	A	5/1991	Hager et al.	
5,199,175	A *	4/1993	Green	33/199 R
5,319,984	A *	6/1994	Humphries et al.	73/862.21
5,350,127	A	9/1994	Arnold et al.	
6,106,088	A	8/2000	Wafler	
7,059,055	B2	6/2006	Wickham et al.	
7,484,427	B2	2/2009	Kolkind	
7,533,471	B2	5/2009	Lange et al.	
7,661,196	B1	2/2010	Kipnes	
7,941,932	B2	5/2011	Kipnes	
2003/0000439	A1	1/2003	Mizuno	
2013/0087086	A1	4/2013	Lizaso	
2015/0204643	A1	7/2015	DeYaeger	
2015/0204644	A1	7/2015	DeYaeger	

OTHER PUBLICATIONS

Emuge Thread Gauge Article, Sep. 2009.

* cited by examiner

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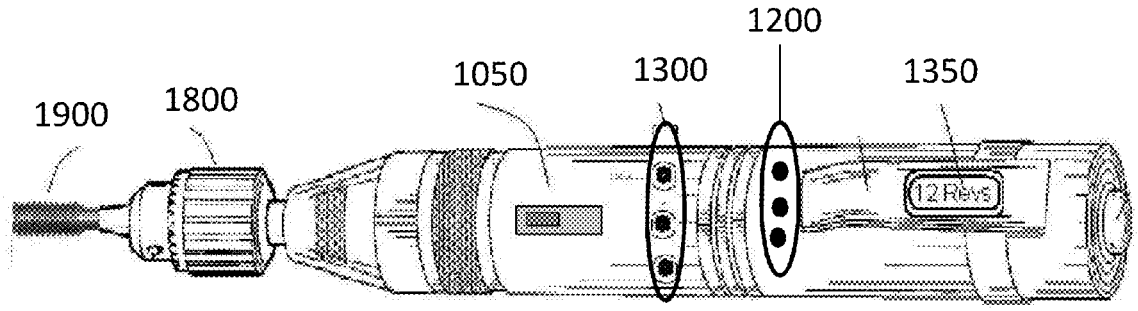
(57) **ABSTRACT**

A thread gauge inspection apparatus includes a receiving member to hold a reference thread gauge and a motor to bi-directionally rotate the reference thread gauge. A counter counts a number of turns the reference thread gauge is rotated by the motor, and a torque monitoring device monitors the torque produced by the motor as the reference thread gauge is rotated. A controller, when the monitored torque exceeds a predetermined value, causes the motor to stop rotating the reference thread gauge and causes the counter to stop counting the number of turns the reference thread gauge is rotated. The controller compares the count produced by the counter with an inputted specific turn count and indicates the thread quality of threaded hole or a threaded stud passed inspection when the count produced by the counter is equal to the inputted specific turn count.

16 Claims, 11 Drawing Sheets



1000

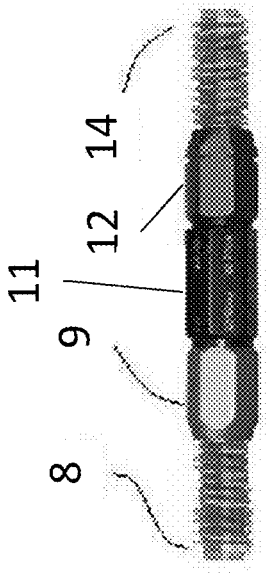


FIGURE 2
(PRIOR ART)

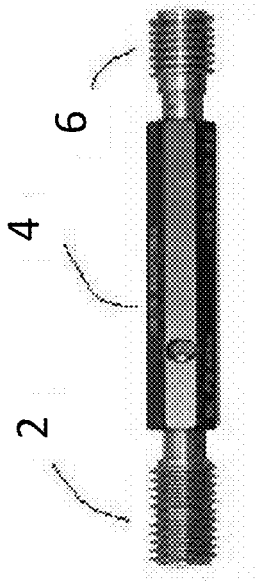


FIGURE 1
(PRIOR ART)

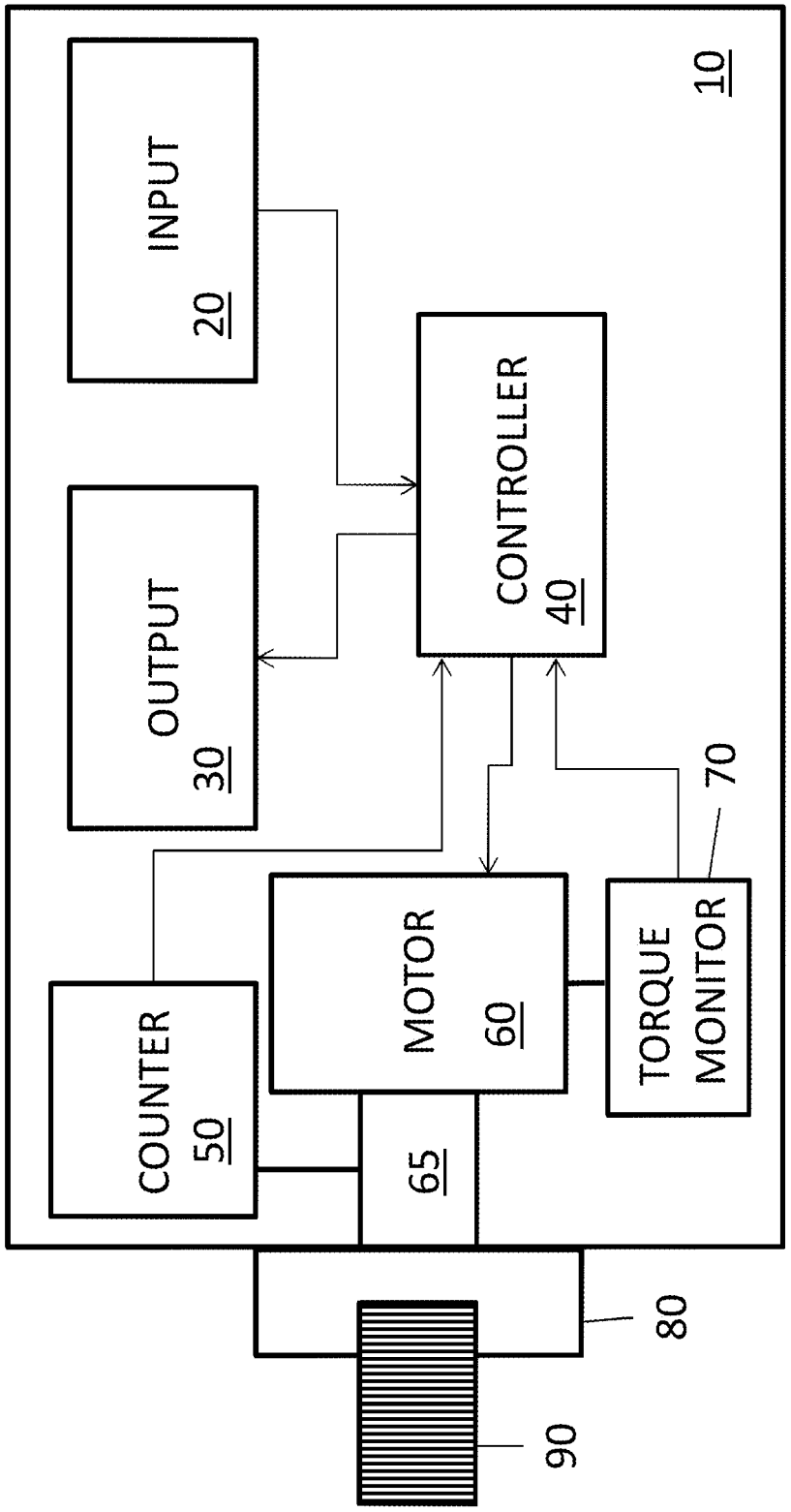

10
INPUT
20
CONTROLLER
40
OUTPUT
30
70
MOTOR
60
TORQUE
MONITOR
COUNTER
50
65
80
90

FIGURE 3

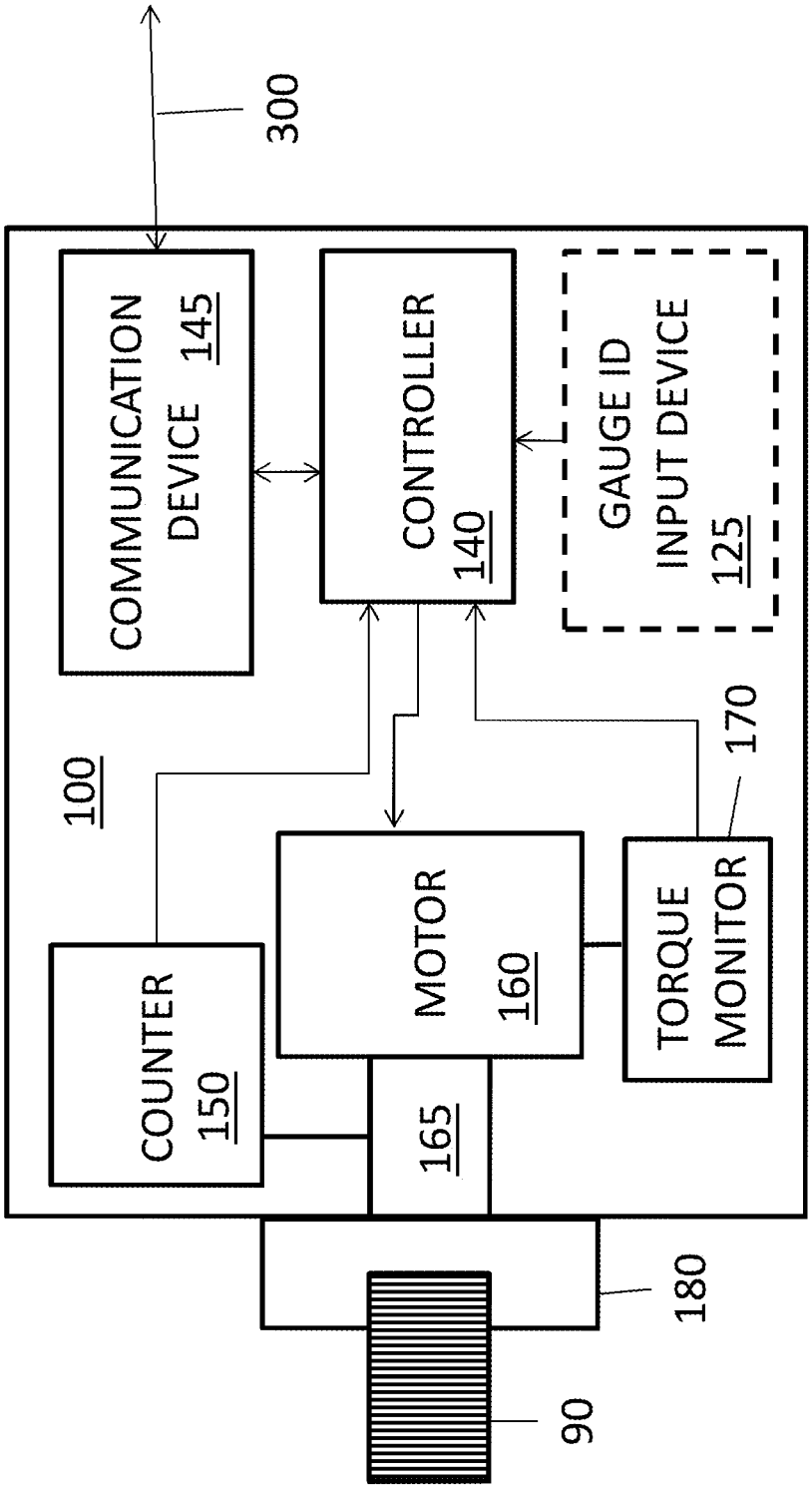

300
COMMUNICATION DEVICE 145
CONTROLLER 140
GAUGE ID INPUT DEVICE 125
100
170
MOTOR 160
TORQUE MONITOR
COUNTER 150
165
180
90

FIGURE 4

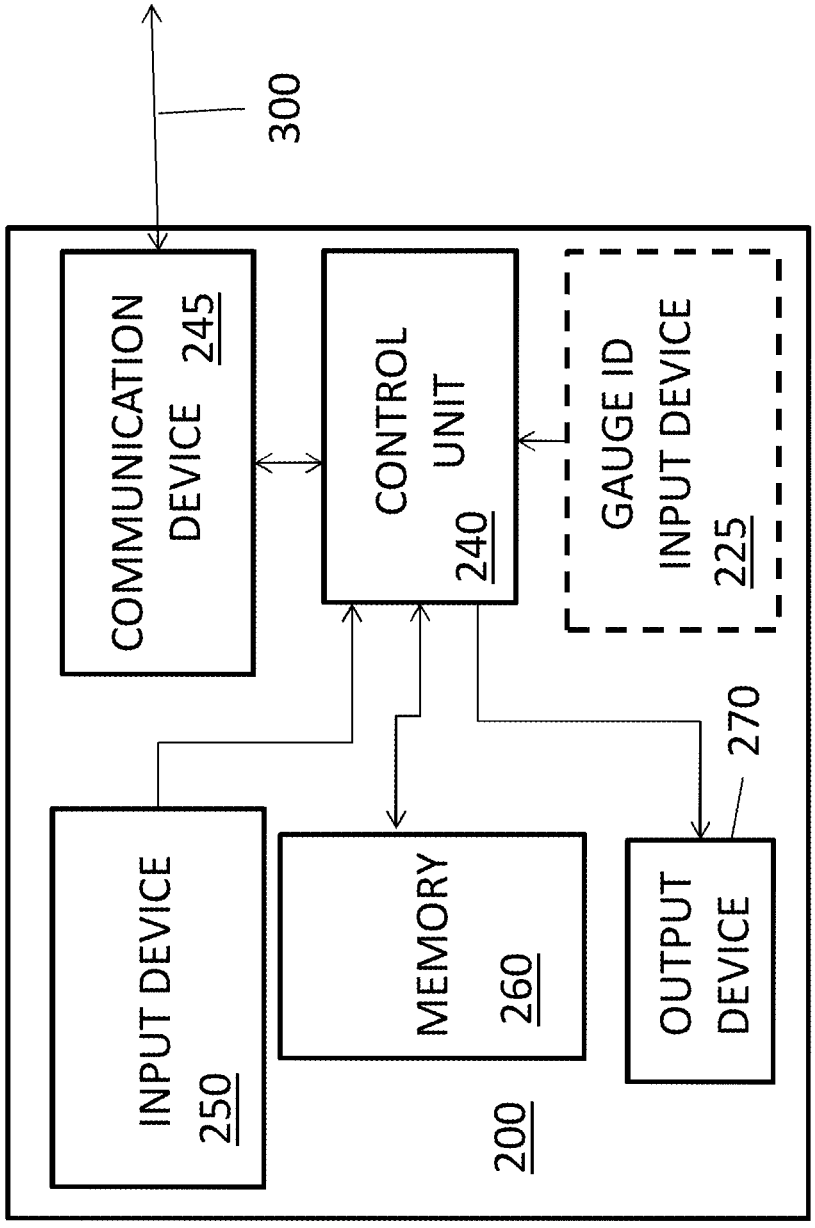

300
COMMUNICATION DEVICE 245
CONTROL UNIT 240
GAUGE ID INPUT DEVICE 225
INPUT DEVICE 250
MEMORY 260
OUTPUT DEVICE
270
200

FIGURE 5

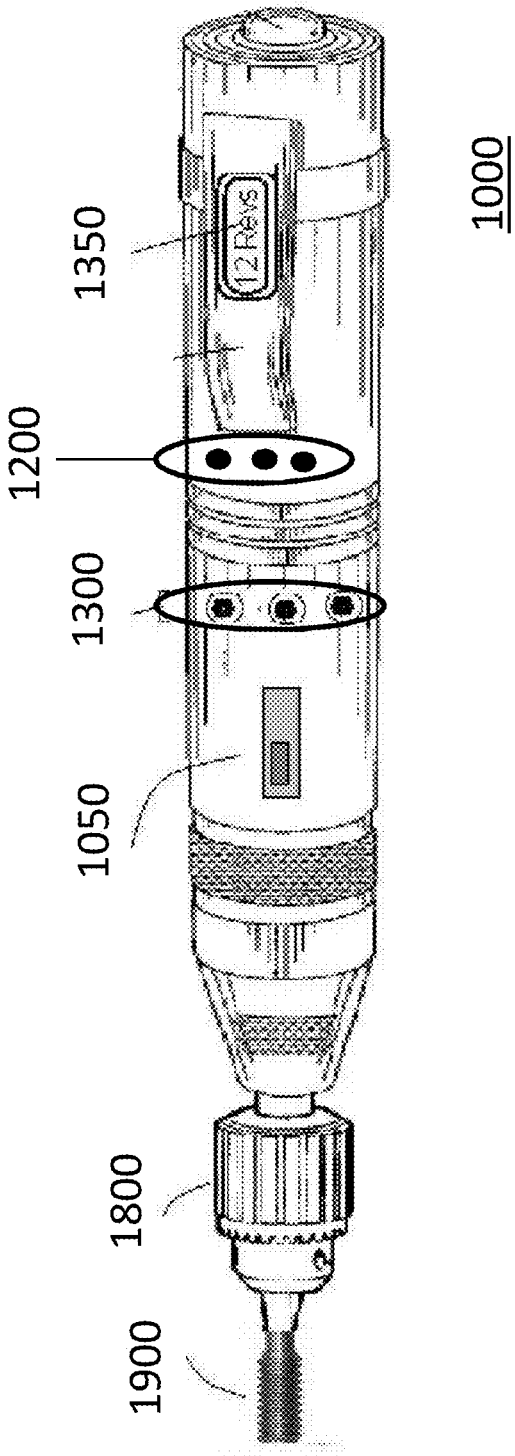


FIGURE 6

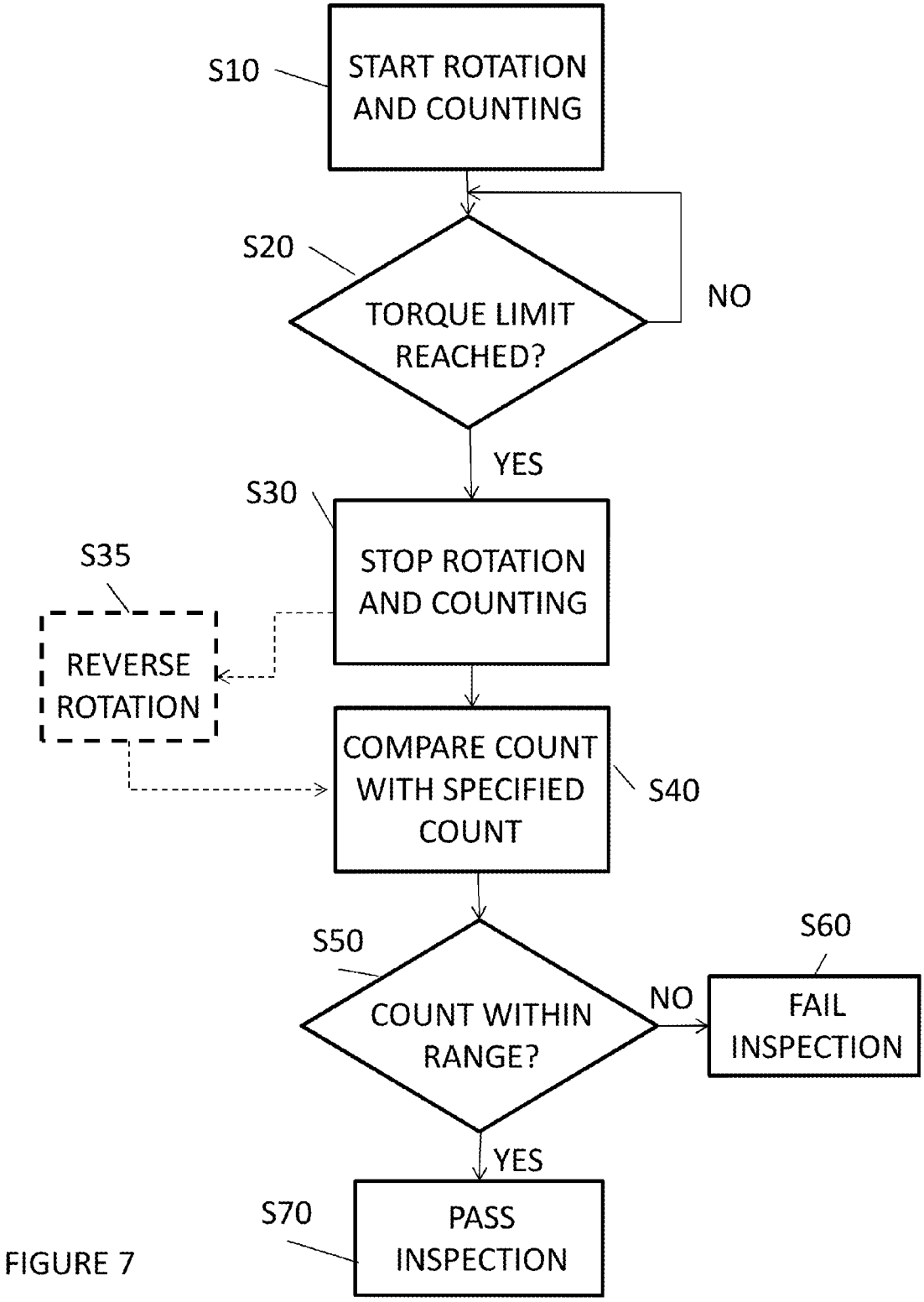

S10
START ROTATION AND COUNTING
S20
TORQUE LIMIT REACHED?
NO
YES
S30
STOP ROTATION AND COUNTING
S35
REVERSE ROTATION
COMPARE COUNT WITH SPECIFIED COUNT
S40
S50
COUNT WITHIN RANGE?
NO
S60
FAIL INSPECTION
YES
S70
PASS INSPECTION

FIGURE 7

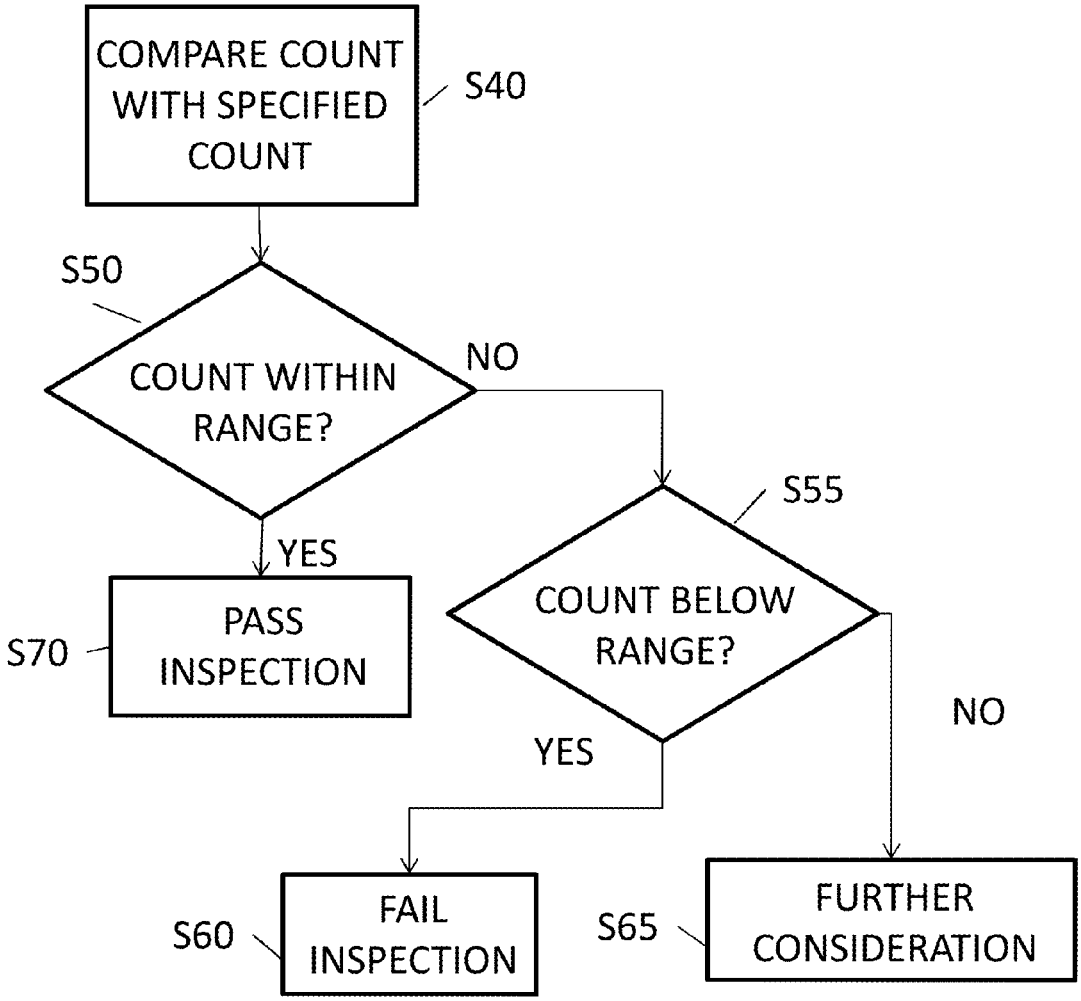

COMPARE COUNT WITH SPECIFIED COUNT
S40
S50
COUNT WITHIN RANGE?
NO
YES
S55
COUNT BELOW RANGE?
YES
NO
S70
PASS INSPECTION
S60
FAIL INSPECTION
S65
FURTHER CONSIDERATION

FIGURE 8

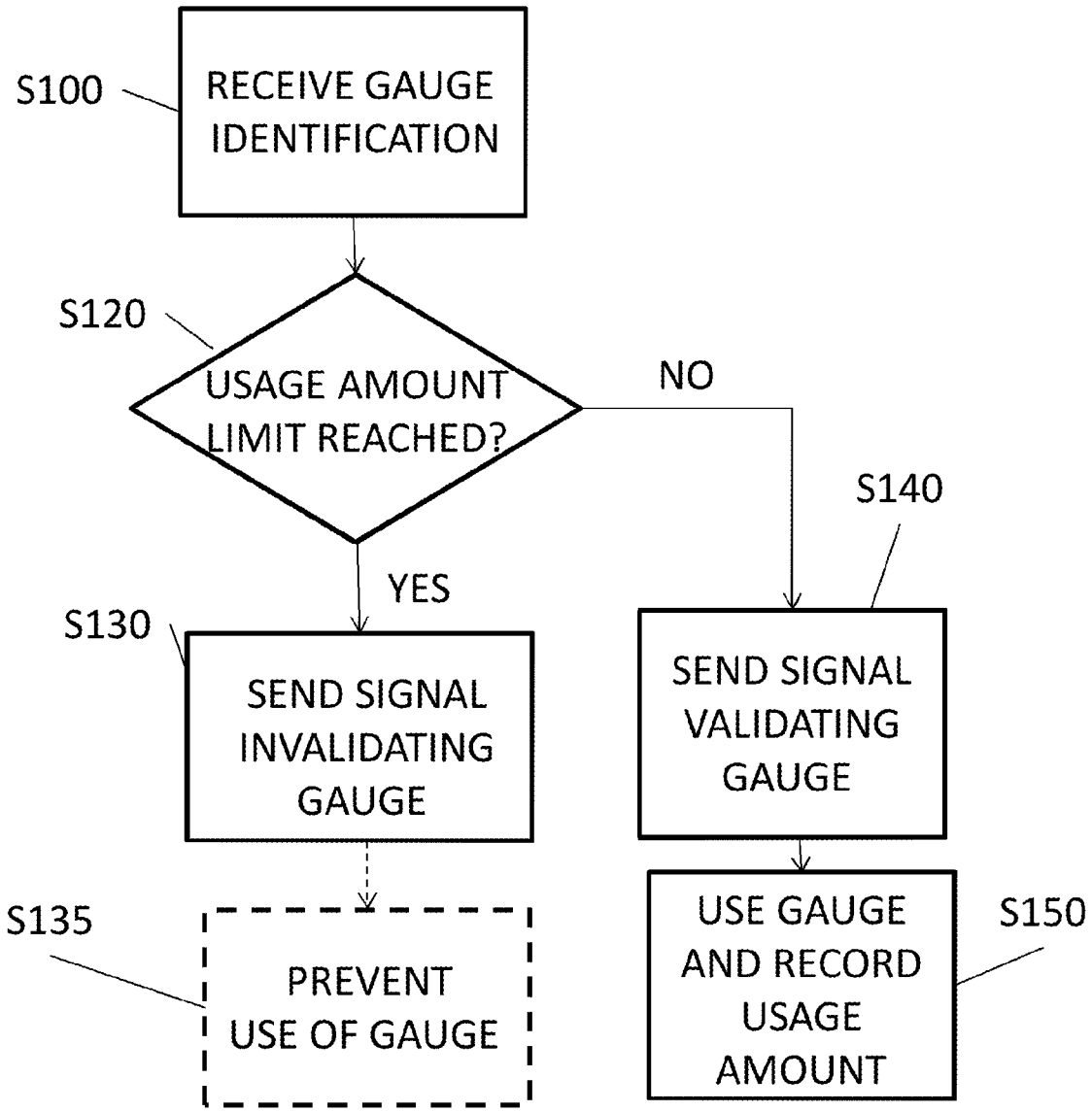

S100
RECEIVE GAUGE IDENTIFICATION
S120
USAGE AMOUNT LIMIT REACHED?
NO
YES
S130
SEND SIGNAL INVALIDATING GAUGE
S135
PREVENT USE OF GAUGE
S140
SEND SIGNAL VALIDATING GAUGE
USE GAUGE AND RECORD USAGE AMOUNT
S150

FIGURE 9

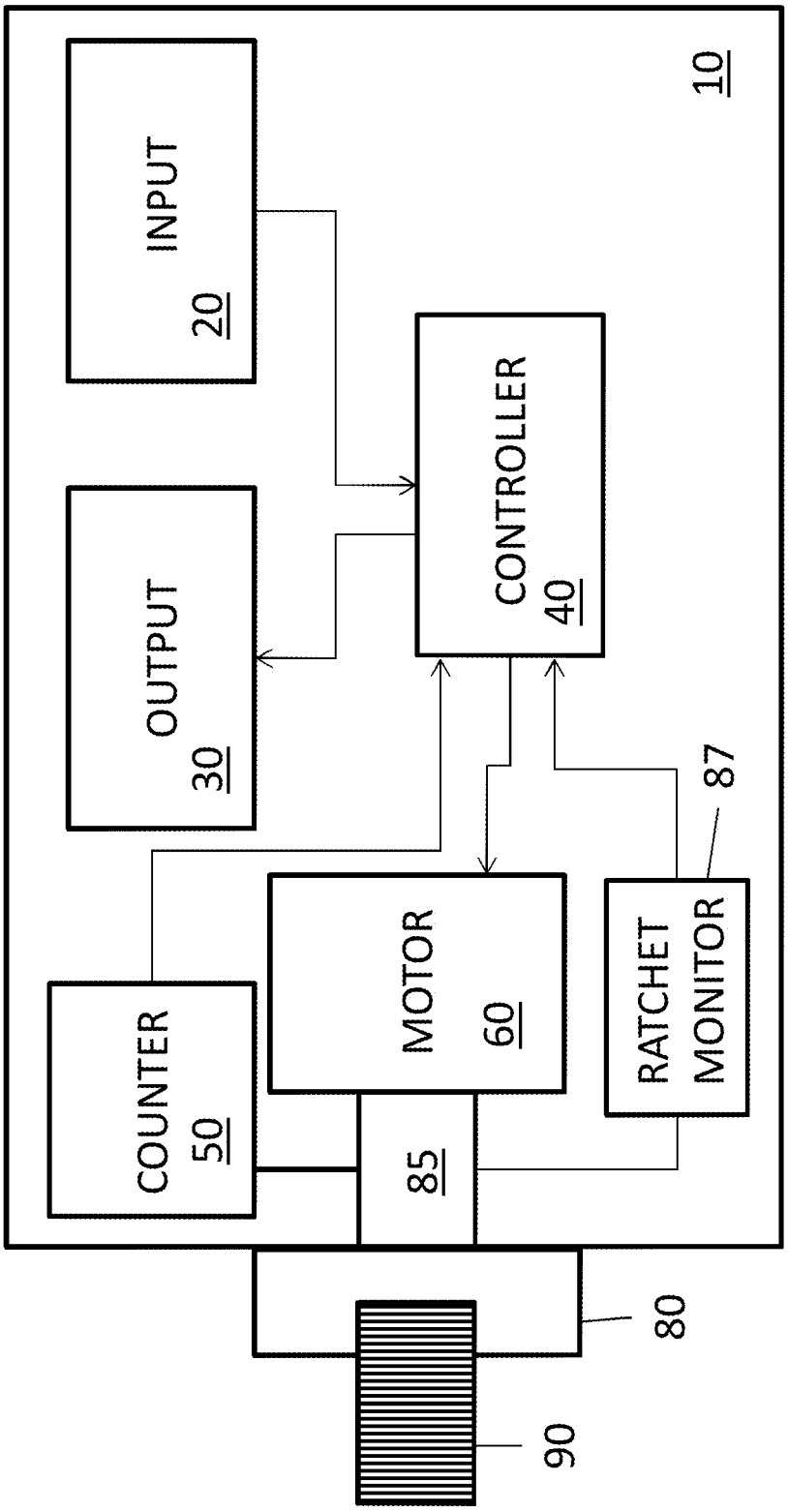

10
INPUT
20
CONTROLLER
40
OUTPUT
30
87
MOTOR
60
RATCHET
MONITOR
COUNTER
50
85
80
90

FIGURE 10

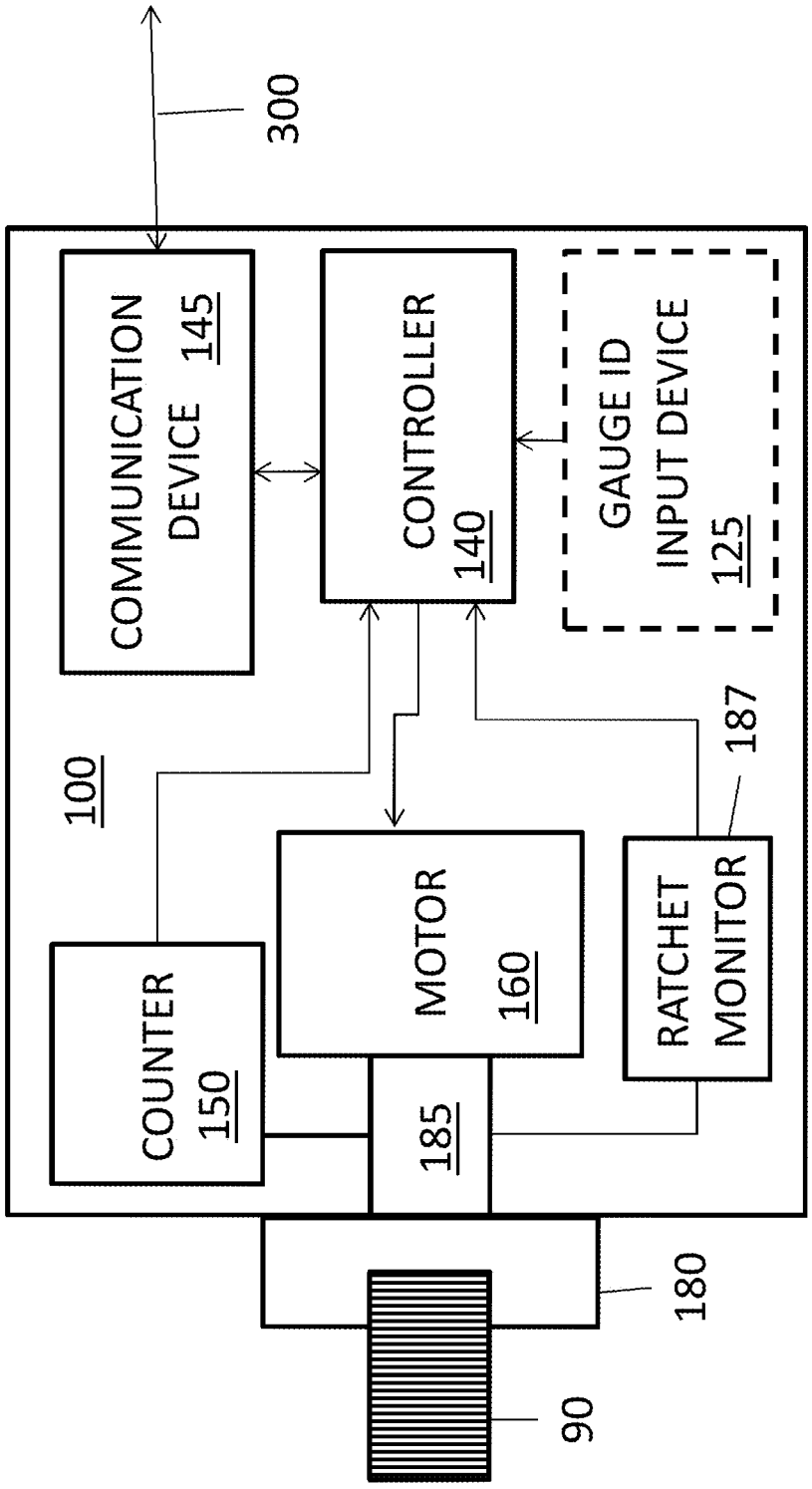

300
COMMUNICATION DEVICE 145
CONTROLLER 140
GAUGE ID INPUT DEVICE 125
100
187
MOTOR 160
RATCHET MONITOR
COUNTER 150
185
180
90

FIGURE 11

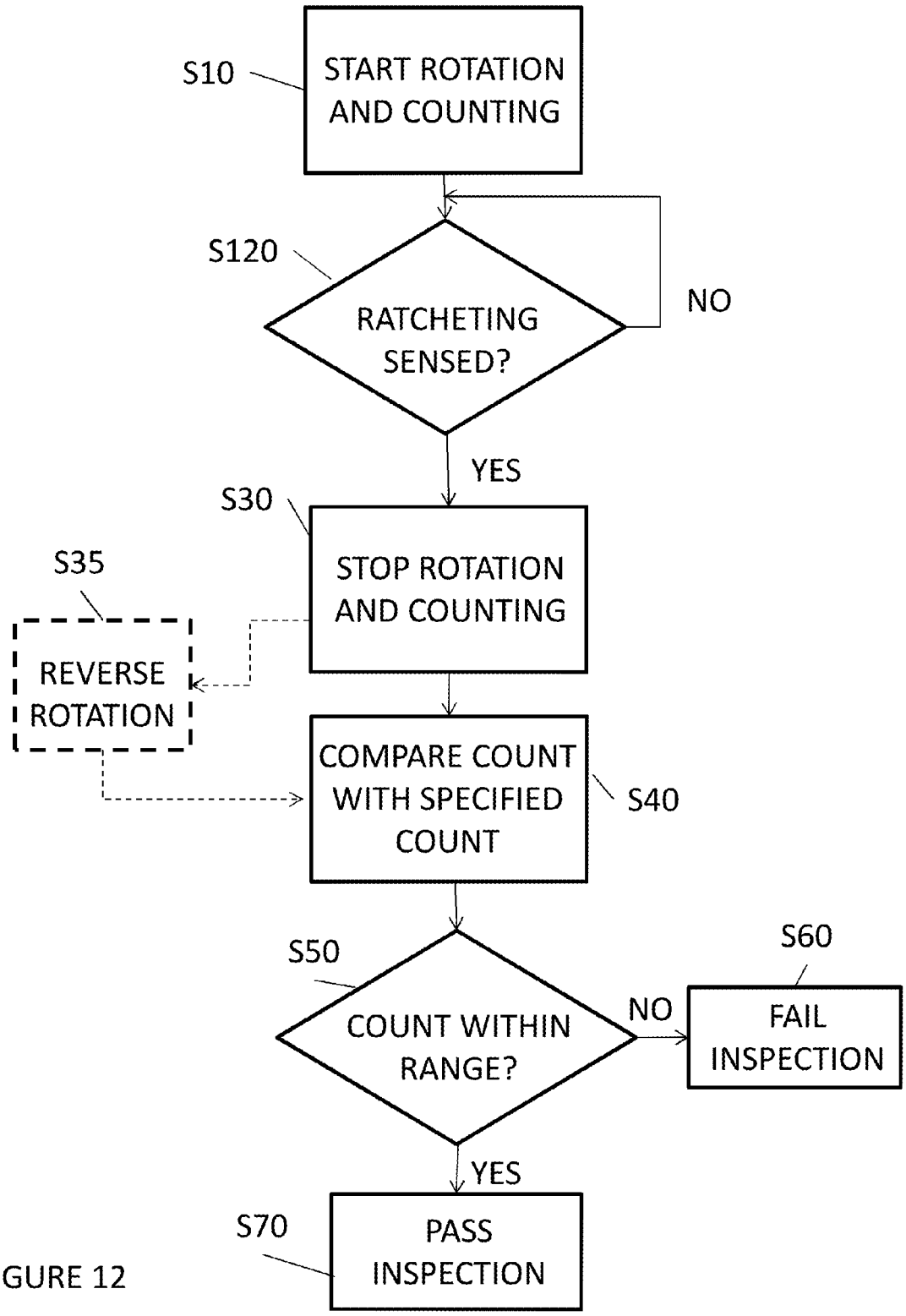

S10
START ROTATION AND COUNTING
S120
RATCHETING SENSED?
NO
YES
S30
STOP ROTATION AND COUNTING
S35
REVERSE ROTATION
COMPARE COUNT WITH SPECIFIED COUNT
S40
S50
COUNT WITHIN RANGE?
NO
S60
FAIL INSPECTION
YES
S70
PASS INSPECTION

FIGURE 12

SYSTEM AND METHOD FOR VERIFYING SCREW THREADS

PRIORITY INFORMATION

The present application claims priority, under 35 U.S.C. §119(e), from U.S. Provisional Patent Application, Ser. No. 61/930,549, filed on Jan. 23, 2014. The entire content of U.S. Provisional Patent Application, Ser. No. 61/930,549, filed on Jan. 23, 2014, is hereby incorporated by reference.

BACKGROUND

Thread inspections are a necessary part of many manufacturing or quality control procedures. These thread inspections may involve the spinning of externally or internally threaded gauges into threaded holes or onto threaded studs, respectively. The threaded holes or studs may be integral parts of machines or just fastener parts, such as nuts or bolts.

Go and No-Go Gauges have been, conventionally, used as screw thread inspection devices, throughout the machining industry, for the functional inspection for acceptable pitch, diameter, lead angle, thread crest, and root dimensions of a thread.

It is further noted that, conventionally, power driven spindles, on which gauges are fitted, have been used to facilitate rapid and uniform testing of screw threads.

For example, U.S. Pat. No. 4,926,700 discloses a blind hole thread gauge using a modified commercial nut driver. U.S. Pat. No. 4,926,700 discloses the use of strain gauges to monitor torque during testing, as well as, sensing when a given hole has been tested to its proper depth. The entire content of U.S. Pat. No. 4,926,700 is hereby incorporated by reference.

In another example, U.S. Pat. No. 7,059,055 discloses a commercial tester for checking the presence of threads in blind holes. Both single spindle and multi-spindle devices are described, which use adjustable slip clutches to limit the torque applied during testing. Upon detecting the proper depth of testing or upon exceeding the torque limit, U.S. Pat. No. 7,059,055 discloses that the tester automatically reverses the drive motor to disengage the gauge from the hole being tested. The entire content of U.S. Pat. No. 7,059,055 is hereby incorporated by reference.

In further examples, U.S. Pat. No. 7,661,196 and U.S. Pat. No. 7,941,932 disclose a compact hand-held ergonomic thread inspection tool that is power driven, which uses current draw or a mechanical clutch, as a surrogate for torque, to initiate automatic reversal and gauge withdrawal in case of jamming. U.S. Pat. No. 7,661,196 and U.S. Pat. No. 7,941,932 disclose that if a maximum torque is reached before a limit sensor is tripped, an alarm is initiated (indicating a defective thread), and the rotation of the thread gauge is reversed.

In other words, U.S. Pat. No. 7,661,196 and U.S. Pat. No. 7,941,932 determine if a threaded hole or stud is too short, the threads are untrue, or the threaded hole or stud is skewed away from the desired axis. The entire contents of U.S. Pat. No. 7,661,196 and U.S. Pat. No. 7,941,932 are hereby incorporated by reference.

As noted above, parts containing blind machined threaded bores often require inspection of the threads to verify for consistency before the machined parts can be shipped or assembled.

For example, the machining specification for a machined threaded bore may call for the machined threaded bore to have between 5.5 and 6.5 turns. In other words, if the machined threaded bore is outside the specified range, the machined threaded bore may be considered defective in view of the machining specifications.

If the machining specification calls for such a specific turn count, the above noted examples may be able to determine if one boundary (under threaded) of the range is met, but these conventional device are not able to determine if the other boundary (over threaded) of the range is met.

Conventionally, when the specification calls for a specific turn count into the bore, the inspection is carried out by a quality control technician, who manually counts the number of turns of the gauge to validate the thread length. However, this conventional counting method presents many issues.

With respect to quality assurance, since the counting is done manually by a quality control technician, the quality control technician may generate a false count if the quality control technician loses count or focus during the procedure. This is especially true when monitoring a large number of turns on a plurality of parts.

Moreover, due to the repetitive manual (turning) nature of the conventional counting technique, a quality control technician is more susceptible to carpal tunnel syndrome.

Therefore, it is desirable to provide a process and/or device for determining if a specific turn count specification has been met, which does not rely upon the manual counting of a quality control technician.

Moreover, it is desirable to provide an ergonomic process and/or device for determining if a specific turn count specification has been met, which is ergonomically designed to reduce the technician's susceptibility to carpal tunnel syndrome.

Furthermore, it is desirable to provide an ergonomic process and/or device for determining if a specific turn count specification has been met, which does not rely upon the manual counting of a quality control technician and is ergonomically designed to reduce the technician's susceptibility to carpal tunnel syndrome.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings are only for purposes of illustrating various embodiments and are not to be construed as limiting, wherein:

FIG. **1** is a representation of a prior art tapered thread gauge and handle;

FIG. **2** is a representation of a prior art reversible thread gauge and handle;

FIG. **3** is a block diagram of a thread gauge inspection apparatus;

FIG. **4** is another block diagram of a thread gauge inspection apparatus;

FIG. **5** is a block diagram of a control system used in conjunction with a thread gauge inspection apparatus;

FIG. **6** is an overall drawing of a thread gauge inspection apparatus;

FIG. **7** is a flowchart of the operations of a thread gauge inspection apparatus;

FIG. **8** is another flowchart of the operations of a thread gauge inspection apparatus;

FIG. **9** is a flowchart for tracking the quality of the reference thread gauge;

FIG. **10** is a block diagram of another embodiment of a thread gauge inspection apparatus;

FIG. **11** is another block diagram of another embodiment of a thread gauge inspection apparatus; and

FIG. **12** is a flowchart of the operations of another embodiment of a thread gauge inspection apparatus.

DETAILED DESCRIPTION

For a general understanding, reference is made to the drawings. In the drawings, like references have been used throughout to designate identical or equivalent elements. It is also noted that the drawings may not have been drawn to scale and that certain regions may have been purposely drawn disproportionately so that the features and concepts could be properly illustrated.

In the following description a reference thread gauge refers to a ring gauge, a thread plug, or other reference (control) gauge device used to test or inspect the physical characteristics (quality) of a machined thread.

For example, a ring gauge, as known to those skilled in the art, is, conventionally, a cylindrical ring, often steel, having an inside diameter finished to gauge tolerance and is used for checking the external diameter of a cylindrical threads. Typically, ring gauges come in pairs (Go and No-Go), wherein the Go ring gauge should rotate onto the part (threaded stud), and the No-Go ring gauge should not rotate onto the part (threaded stud).

On other hand, a thread plug, as known to those skilled in the art, conventionally, is a plug (cylinder), often steel, having an outside diameter finished to gauge tolerance and is used to inspect the inside diameter of a tapped hole with a Go, No-Go system. The Go portion of the thread plug should rotate into the part (threaded hole), and the No-Go portion of the thread plug should not rotate into the part (threaded hole).

It is noted that a machined thread may be created by a machine rotating a threading device or a threading device being manually rotated by an operator.

In FIG. **1**, a conventional "Go" gauge **2** has a tapered shank which corresponds to a tapered bore within holder **4**, which is also the same for a conventional "No-Go" gauge **6** on the opposing end.

In FIG. **2**, a handle **11** includes two collets, collet **9** for the conventional "Go" gauge **8** and collet **12** for a conventional "No-Go" gauge **14**. In this example, the gauge is threaded so as to be able to be flipped end for end when one end is worn out, effectively doubling the useful life of the gauge.

As illustrated in FIGS. **1** and **2**, the gauge is grasped and manually turned to inspect a threaded hole. Such a manual inspection process can produced false results due to miscounts and makes the technician more susceptible to carpal tunnel syndrome.

FIG. **3** illustrates a block diagram of a thread gauge inspection apparatus **10**. The thread gauge inspection apparatus **10** includes an input device **20** which enables the inputting of a specific turn count corresponding to inspection of a thread quality of a threaded hole or a threaded stud. The input device **20** may be a keypad, a set of buttons (one button corresponding to a ones unit value, a second button corresponding to a tens unit value, and a third button corresponding to a hundreds unit value), a set of dials (one dial corresponding to a ones unit value, a second dial corresponding to a tens unit value, and a third dial corresponding to a hundreds unit value), etc. It is noted that the input device receive the specific turn count optically, electrically, magnetically, manually, wirelessly.

An output device **30** communicates a result of the inspection of the thread quality of the threaded hole or the threaded stud. The output device **30** may also communicate, in real-time, the actual number of turns a reference thread gauge **90** is turned with respect to the threaded hole or threaded stud being inspected.

The output device **30** may be a LCD or LED display for displaying the result of the inspection and/or the actual number of turns. Moreover, the output device **30** may be a set of lights for displaying the result of the inspection (a green light corresponding to a passing status, a red light corresponding to a failing status, and/or yellow light corresponding to a need further consideration status).

The thread gauge inspection apparatus **10** includes a receiving member **80** to hold the reference thread gauge **90**. A rotation device (electric motor) **60** bi-directionally rotates the reference thread gauge **90** through the receiving member **80** and a shaft **65**. It is noted that rotation device (electric motor) **60** may be coupled directly to the receiving member **80**, thereby eliminating the need for a shaft **65**.

The rotation device (electric motor) **60** rotates the reference thread gauge **90** in a first direction to drive the reference thread gauge **90** into a threaded hole being inspected or onto a threaded stud being inspected.

The rotation device (electric motor) **60** rotates the reference thread gauge **90** in a second direction to drive the reference thread gauge **90** out of a threaded hole being inspected or off of a threaded stud being inspected.

The rotation device (electric motor) **60** may be a DC permanent magnet gear motor, which rotates the reference thread gauge **90** at a slow speed, such as, for example, 150 to 200 rpm, or other desired slow speed.

This type of motor has a torque constant expressed simply in terms of oz-in/amp or N-m/amp at the motor shaft. The torque at the output of the gear box (which spins the reference thread gauge **90**) can be determined from current draw of the motor by simply reading the current, applying the torque constant, and multiplying by the reciprocal of the gearbox speed reduction ratio.

The thread gauge inspection apparatus **10** also includes a counter **50** that counts a number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **60** in the first direction. The counter **50** may be an optical encoder coupled to the shaft **65** or receiving member **80**.

The counter **50** may also be a mechanical encoder, an electrical encoder, or a magnetic encoder coupled to the shaft **65** or receiving member **80**.

A torque monitoring device **70**, operatively connected to the rotation device (electric motor) **60**, monitors the torque produced by the rotation device (electric motor) **60** as the reference thread gauge **90** is rotated by the rotation device (electric motor) **60** in the first direction.

Examples of conventional torque monitoring devices are described in U.S. Pat. No. 7,661,196 and U.S. Pat. No. 7,941,932. The entire contents of U.S. Pat. No. 7,661,196 and U.S. Pat. No. 7,941,932 are hereby incorporated by reference.

Torque produced by the rotation device (electric motor) **60**, as the reference thread gauge **90** is driven into a threaded hole being inspected or onto a threaded stud being inspected, is monitored. The torque may be monitored by monitoring the current drawn by the rotation device (electric motor) **60**, which may be, for example, a DC permanent magnet gear motor. The current draw limit may be related to the predetermined torque limit by incorporating empirically determined gear box parameters, such as gear box ratio, gear box friction factor, and an additive factor in addition to the motor torque constant.

When a predetermined limit of torque is exceeded, the torque monitoring device **70** generates a signal indicating that the predetermined limit of torque has been exceeded. This signal is outputted to a controller **40**.

The controller **40** may be a processor, microprocessor, an application specific integrated circuit, electronic circuitry,

and/or combination thereof. The controller **40**, is not, as is well known by those skilled in the art, purely software because software cannot by itself perform functions, but can only perform functions in conjunction with hardware.

The controller **40**, when the monitored torque exceeds the predetermined limit, causes the rotation device (electric motor) **60** to stop rotating the reference thread gauge **90** in the first direction.

The controller **40**, when the monitored torque exceeds the predetermined limit, also causes the counter **50** to stop counting the number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **60** in the first direction. The controller **40** compares the count produced by the counter **50** with the inputted specific turn count.

The output device **30** may indicate, when the count produced by the counter **50** is equal to the inputted specific turn count, that the thread quality of the threaded hole or the threaded stud passed inspection.

The thread gauge inspection apparatus **10**, when the count is less than the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is greater than the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is within a predetermined range, the predetermined range including the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud passed inspection.

The thread gauge inspection apparatus **10**, when the count is outside a predetermined range, the predetermined range including the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is greater than an upper boundary value of a predetermined range, the predetermined range including the inputted specific turn count, causes the output device to indicate the thread quality of the threaded hole or the threaded stud needs further consideration.

It is noted that that the thread gauge inspection apparatus **10** may include a means to manually rotate the reference thread gauge **90**. In this example, the torque monitoring device is not needed as the technician can feel the torque.

In the manually rotated device, the determination of the status of the inspection can be automatic by the controller **40**, upon receiving a signal that the rotations have stopped or be manually by the technician by comparing the displayed number of turns with a specified number of turns.

FIGS. **4** and **5** illustrate a block diagram of a thread gauge inspection system, wherein FIG. **4** illustrates a thread gauge inspection apparatus **100** and FIG. **5** illustrates a thread gauge inspection control system **200**.

The thread gauge inspection apparatus **100** of FIG. **4** includes a receiving member **180** to hold the reference thread gauge **90**. A rotation device (electric motor) **160** bi-directionally rotates the reference thread gauge **90** through the receiving member **180** and a shaft **165**. It is noted that rotation device (electric motor) **160** may be coupled directly to the receiving member **180**, thereby eliminating the need for a shaft **165**.

The rotation device (electric motor) **160** rotates the reference thread gauge **90** in a first direction to drive the reference thread gauge **90** into a threaded hole being inspected or onto a threaded stud being inspected.

The rotation device (electric motor) **160** rotates the reference thread gauge **90** in a second direction to drive the reference thread gauge **90** out of a threaded hole being inspected or off of a threaded stud being inspected.

The rotation device (electric motor) **160** may be a DC permanent magnet gear motor, which rotates the reference thread gauge **90** at a slow speed, such as, for example, 150 to 200 rpm, or other desired slow speed.

The thread gauge inspection apparatus **100** also includes a counter **150** that counts a number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction. The counter **150** may be an optical encoder coupled to the shaft **165** or receiving member **180**.

The counter **150** may also be a mechanical encoder, an electrical encoder, or a magnetic encoder coupled to the shaft **165** or receiving member **180**.

A torque monitoring device **170**, operatively connected to the rotation device (electric motor) **160**, monitors the torque produced by the rotation device (electric motor) **160** as the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction.

When a predetermined limit of torque is exceeded, the torque monitoring device **170** generates a signal indicating that the predetermined limit of torque has been exceeded. This signal is outputted to a controller **140**.

The controller **140** may be a processor, microprocessor, an application specific integrated circuit, electronic circuitry, and/or combination thereof. The controller **140**, is not, as is well known by those skilled in the art, purely software because software cannot by itself perform functions, but can only perform functions in conjunction with hardware.

The controller **140**, when the monitored torque exceeds the predetermined limit, causes the rotation device (electric motor) **160** to stop rotating the reference thread gauge **90** in the first direction.

The controller **140**, when the monitored torque exceeds the predetermined limit, also causes the counter **150** to stop counting the number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction. The controller **140** compares the count produced by the counter **150** with an inputted specific turn count.

The inputted specific turn count may be inputted through an input device as described with respect to FIG. **3**, or the inputted specific turn count may be inputted through a communication device **145**. The communication device **145** is in communication with communication device **245** of the thread gauge inspection control system **200** of FIG. **5**. The communication devices **145** and **245** communicate over communication channel **300**. Thus, the inputted specific turn count may be inputted through input device **250** of FIG. **5** and communicated to the thread gauge inspection apparatus **100**.

Communication channel **300** may be a wired channel, a fiber channel, a wireless channel, or an optical channel.

In another embodiment, the controller **140**, when the monitored torque exceeds the predetermined limit, causes the counter **150** to stop counting the number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction communicates the count

produced by the counter **150** to the thread gauge inspection control system **200** of FIG. **5** for determining of inspection status.

The thread gauge inspection apparatus **100** may include an output device (not shown) to indicate, when the count produced by the counter **150** is equal to the inputted specific turn count, that the thread quality of the threaded hole or the threaded stud passed inspection. This output device may perform all the functions described with respect to the output device **30** of FIG. **3**.

The thread gauge inspection apparatus **100** may also include a gauge identification input device **125** to enable a technician to input the identification of the reference thread gauge **90**.

The gauge identification input device **125** may be a keypad for entering the numeric or alphanumeric identification of the reference thread gauge **90**.

The gauge identification input device **125** may also be a barcode reader for reading a barcode containing the identification of the reference thread gauge **90**. The barcode may be located on the reference thread gauge **90** or on a separate piece associated with the reference thread gauge **90**.

The gauge identification input device **125** may be a magnetic or RFID reader for acquiring the identification of the reference thread gauge **90**.

To identify the reference thread gauge **90**, the reference thread gauge **90** may include human-readable numeric and/or alphanumeric markings thereon for the technician to read and enter into the system. The reference thread gauge **90** may include a barcode thereon to provide identification, a RFID to provide identification, a magnetic strip to provide identification, and/or physical features (key), which can be mechanically detected to provide identification.

As illustrated in FIG. **5**, a thread gauge inspection control system **200** includes a control unit **240**.

The control unit **240** may be a processor, microprocessor, an application specific integrated circuit, electronic circuitry, and/or combination thereof. The controller control unit **240**, is not, as is well known by those skilled in the art, purely software because software cannot by itself perform functions, but can only perform functions in conjunction with hardware.

The thread gauge inspection control system **200** also includes an input device **250**, which may be a keyboard, keypad, an electronic pointing device, a touch pad, a touchscreen, any other device and/or combination thereof for enabling input of data to the control unit **240**. The input device **250** enables a technician to input a specified turn count to be utilized in the inspection process. The input device **250** may also enable a technician to input identification information relating to the reference thread gauge being used in the inspection process. Lastly, the input device **250** may enable a technician or user input other information or data relative to the inspection process to the thread gauge inspection control system **200**.

The thread gauge inspection control system **200** includes an output device **250**, which may be a display screen, a LED display, a LCD display, a printer, or any other device for enabling the outputting of data from the control unit **240**.

The thread gauge inspection control system **200** includes a memory **260**, which stores data and/or application software for the thread gauge inspection control system **200**.

The thread gauge inspection control system **200** may also include a gauge identification input device **225** to enable a technician to input the identification of the reference thread gauge **90**.

The gauge identification input device **225** may be a keypad for entering the numeric or alphanumeric identification of the reference thread gauge **90**.

The gauge identification input device **225** may also be a barcode reader for reading a barcode containing the identification of the reference thread gauge **90**. The barcode may be located on the reference thread gauge **90** or on a separate piece associated with the reference thread gauge **90**.

The gauge identification input device **225** may be a magnetic or RFID reader for acquiring the identification of the reference thread gauge **90**.

To identify the reference thread gauge **90**, the reference thread gauge **90** may include human-readable numeric and/or alphanumeric markings thereon for the technician to read and enter into the system. The reference thread gauge **90** may include a barcode thereon to provide identification, a RFID to provide identification, a magnetic strip to provide identification, and/or physical features (key), which can be mechanically detected to provide identification.

FIG. **6** illustrates a general view of a thread gauge inspection apparatus **1000**. As illustrated in FIG. **6**, reference thread gauge **1900** is removably coupled to chuck **1800** using a chuck key (not shown) to secure a shank of the reference thread gauge **1900** to a motorized driver (not shown).

An ON/OFF switch **1050** provides user manual control of starting and stopping the inspection process

As noted above, the ability to attain the specified rotations of the reference thread gauge **1900** into a threaded bore is predicated on the quality and depth of the threads. In the case of a non-conforming thread, the torque required to turn the reference thread gauge **1900** exceeds the predetermined torque limit, and the rotation of the reference thread gauge **1900** is stopped.

As illustrated in FIG. **6**, thread gauge inspection apparatus **1000** includes switches or buttons **1300**, which serve to input the number of turns that must at least be accomplished for the test to be successful. A one's unit switch/button, a ten's unit switch/button, and hundred's switch/button, used in combination, allows a technician to input a specified revolution count to be utilized in the inspection process.

It is noted that the switches or buttons **1300** can have a dual operation such as a reset, clear and the like.

The thread gauge inspection apparatus **1000** may include a display **1350** is a visual output device which communicates the required (specified) turns (or the real time turn count when in use).

Display **1350** may display other information/data such as; remaining battery charge, motor torque, reference thread gauge ID, revolution direction, job number, number of tests run, date/time and any other information of potential interest to the operator, as well as quality assurance management.

The thread gauge inspection apparatus **1000** may also include a series of lights (displays) **1200**, which convey the status of the inspection (a green light corresponding to a passing status, a red light corresponding to a failing status, and/or yellow light corresponding to a need further consideration status).

The thread gauge inspection apparatus **1000** may also include (not shown) a power source, which may be an internal rechargeable battery or power provide through an external wire.

It is noted that the integrated battery may be a removable battery pack to allow for the interchange of power packs while one is recharging.

The thread gauge inspection apparatus **1000** may also include (not shown) a power interface to allow the thread gauge inspection apparatus **1000** to be placed into a charging station when not in use.

FIG. **7** illustrates a flowchart showing a thread gauge inspection process. As illustrated in FIG. **7**, a reference thread gauge begins rotating at step S**10**, the process of counting the number of turns that the reference thread gauge makes is started at step S**10**.

The rotating of reference thread gauge and the count process continues until step S**20** determines (NO branch) that the torque on the reference thread gauge exceeds a predetermined limit.

As previously noted, the monitoring of the torque on a reference thread gauge is well known to those skilled in the art.

If step S**20** determines (YES branch) that the torque on the reference thread gauge exceeds a predetermined limit, the rotating of reference thread gauge and the count process are stopped at step S**30**.

At step S**40**, the count generated by the count process is compared with a specified count. The specified count can be inputted into the process before the inspection process is started. The specified count is the value used to determine the inspection status of the threads under test.

Optionally, at step S**35**, the rotation of the reference thread gauge can be reversed to disengage the reference thread gauge from the thread under test.

At step S**50**, it is determined if the count generated by the count process is within a predetermined range of the specified count.

If the count generated by the count process is within a predetermined range of the specified count (YES branch), step S**70** indicates that the thread under test passes inspection.

If the count generated by the count process is not within a predetermined range of the specified count (No branch), step S**60** indicates that the thread under test failed inspection.

FIG. **8** illustrates another flowchart showing an alternative inspection status determination. As illustrated in FIG. **8**, at step S**40**, the count generated by the count process is compared with a specified count.

At step S**50**, it is determined if the count generated by the count process is within a predetermined range of the specified count.

If the count generated by the count process is within a predetermined range of the specified count (YES branch), step S**70** indicates that the thread under test passes inspection.

If the count generated by the count process is not within a predetermined range of the specified count (No branch), step S**55** determines if the count generated by the count process is below (less than) the predetermined range of the specified count.

If the count generated by the count process is below (less than) the predetermined range of the specified count (YES branch), step S**60** indicates that the thread under test failed inspection.

If the count generated by the count process is not below (greater than) the predetermined range of the specified count (YES branch), step S**65** indicates that the thread under test needs further consideration.

With respect to the range discussed above, an inspection process may consider a thread as passing inspection if the count value is +/−0.5 turns of the specified turn count.

Thus, if the specified turn count is 6 turns, a count between 5.5 and 6.5 turns would trigger a pass inspection status, as illustrated in FIG. **8**. However, in this example, a turn count of 5 would trigger a failed inspection status, as illustrated in FIG. **8**.

In certain situations, a count less than the lower boundary of the specified count range is unacceptable, but a count greater than an upper boundary of the specified count range may be acceptable after further consideration or inspection, as illustrated in FIG. **8**.

FIG. **9** illustrates a flowchart for checking if the reference thread gauge can be utilized in the inspection process. As is known to those skilled in the art, reference thread gauges need to be periodically recalibrated due to wear from the inspection process. The process of FIG. **9** provides the monitoring of the usage of a reference thread gauge and determination if the reference thread gauge is needs calibration before use.

As illustrated in FIG. **9**, at step S**100**, the identification of the reference thread gauge is received. The identification information is used to retrieve usage information from a database to determine, at step S**120**, if the usage amount for the identified reference thread gauge is below a predetermined usage limit, the predetermined usage limit corresponding to the upper usage amount before a reference thread gauge needs to be recalibrated.

If the identified reference thread gauge is below the predetermined usage limit (NO branch), step S**140** generates a signal indicating that the identified reference thread gauge is usable.

This signal can be used to inform the technician of the status of the identified reference thread gauge or the signal can be used to enable the operation of a thread gauge inspection apparatus in conjunction with the identified reference thread gauge.

If the identified reference thread gauge is at or above the predetermined usage limit (YES branch), step S**130** generates a signal indicating that the identified reference thread gauge is not usable.

This signal can be used to inform the technician of the status of the identified reference thread gauge or the signal can be used to disable the operation of a thread gauge inspection apparatus in conjunction with the identified reference thread gauge (step S**135**).

If the identified reference thread gauge is utilized in an inspection process, its usage tracked and recorded, at step S**150**. The usage amount may be conveyed back to a control system for entering into a database which identifies a reference thread gauge usage amount between calibrations.

By monitoring the identification of the reference thread gauge and its usage, a system can maintain appropriate quality control with respect to utilizing calibrated reference thread gauges and preventing the use of un-calibrated reference thread gauges.

FIG. **10** illustrates a block diagram of another embodiment of a thread gauge inspection apparatus **10**. The thread gauge inspection apparatus **10** includes an input device **20** which enables the inputting of a specific turn count corresponding to inspection of a thread quality of a threaded hole or a threaded stud.

The input device **20** may be a keypad, a set of buttons (one button corresponding to a ones unit value, a second button corresponding to a tens unit value, and a third button corresponding to a hundreds unit value), a set of dials (one dial corresponding to a ones unit value, a second dial corresponding to a tens unit value, and a third dial corresponding to a hundreds unit value), etc. It is noted that the input device receive the specific turn count optically, electrically, magnetically, manually, wirelessly.

An output device **30** communicates a result of the inspection of the thread quality of the threaded hole or the threaded stud. The output device **30** may also communicate, in real-time, the actual number of turns a reference thread gauge **90** is turned with respect to the threaded hole or threaded stud being inspected. The output device **30** may be a LCD or LED display for displaying the result of the inspection and/or the actual number of turns. Moreover, the output device **30** may be a set of lights for displaying the result of the inspection (a green light corresponding to a passing status, a red light corresponding to a failing status, and/or yellow light corresponding to a need further consideration status).

The thread gauge inspection apparatus **10** includes a receiving member **80** to hold the reference thread gauge **90**. A rotation device (electric motor) **60** bi-directionally rotates the reference thread gauge **90** through the receiving member **80** and a shaft/ratchet **85**.

The rotation device (electric motor) **60** rotates the reference thread gauge **90** in a first direction to drive the reference thread gauge **90** into a threaded hole being inspected or onto a threaded stud being inspected.

The rotation device (electric motor) **60** rotates the reference thread gauge **90** in a second direction to drive the reference thread gauge **90** out of a threaded hole being inspected or off of a threaded stud being inspected.

The rotation device (electric motor) **60** may be a DC permanent magnet gear motor, which rotates the reference thread gauge **90** at a slow speed, such as, for example, 150 to 200 rpm, or other desired slow speed.

This type of motor has a torque constant expressed simply in terms of oz-in/amp or N-m/amp at the motor shaft. The torque at the output of the gear box (which spins the reference thread gauge **90**) can be determined from current draw of the motor by simply reading the current, applying the torque constant, and multiplying by the reciprocal of the gearbox speed reduction ratio.

The thread gauge inspection apparatus **10** also includes a counter **50** that counts a number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **60** in the first direction. The counter **50** may be an optical encoder coupled to the shaft/ratchet **85** or receiving member **80**.

The counter **50** may also be a mechanical encoder, an electrical encoder, or a magnetic encoder coupled to the shaft/ratchet **85** or receiving member **80**.

A ratchet monitoring device **87**, operatively connected to the shaft/ratchet **85**, monitors the ratcheting of the shaft/ratchet **85** as the reference thread gauge **90** is rotated by the rotation device (electric motor) **60** in the first direction.

When a predetermined limit of torque is exceeded, the shaft/ratchet **85** will begin to ratchet in that the rotation device (electric motor) **60** may continue to turn but the receiving member **80** or the reference thread gauge **90** will no longer turn. Upon sensing the ratcheting, the ratchet monitoring device **87** generates a signal indicating that the predetermined limit of torque has been exceeded. This signal is outputted to a controller **40**.

The controller **40** may be a processor, microprocessor, an application specific integrated circuit, electronic circuitry, and/or combination thereof. The controller **40**, is not, as is well known by those skilled in the art, purely software because software cannot by itself perform functions, but can only perform functions in conjunction with hardware.

The controller **40**, when the monitored torque exceeds the predetermined limit, causes the rotation device (electric motor) **60** to stop rotating the reference thread gauge **90** in the first direction.

The controller **40**, when the monitored torque exceeds the predetermined limit, also causes the counter **50** to stop counting the number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **60** in the first direction. The controller **40** compares the count produced by the counter **50** with the inputted specific turn count.

The output device **30** may indicate, when the count produced by the counter **50** is equal to the inputted specific turn count, that the thread quality of the threaded hole or the threaded stud passed inspection.

The thread gauge inspection apparatus **10**, when the count is less than the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is greater than the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is within a predetermined range, the predetermined range including the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud passed inspection.

The thread gauge inspection apparatus **10**, when the count is outside a predetermined range, the predetermined range including the inputted specific turn count, may indicate that the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus **10**, when the count is greater than an upper boundary value of a predetermined range, the predetermined range including the inputted specific turn count, causes the output device to indicate the thread quality of the threaded hole or the threaded stud needs further consideration.

It is noted that that the thread gauge inspection apparatus **10** may include a means to manually rotate the reference thread gauge **90**. In this example, the torque monitoring device is not needed as the technician can feel the torque.

In the manually rotated device, the determination of the status of the inspection can be automatic by the controller **40**, upon receiving a signal that the rotations have stopped or be manually by the technician by comparing the displayed number of turns with a specified number of turns.

FIG. **11** illustrates another embodiment of a thread gauge inspection apparatus **100**.

The thread gauge inspection apparatus **100** of FIG. **11** includes a receiving member **180** to hold the reference thread gauge **90**. A rotation device (electric motor) **160** bi-directionally rotates the reference thread gauge **90** through the receiving member **180** and a shaft/ratchet **185**.

The rotation device (electric motor) **160** rotates the reference thread gauge **90** in a first direction to drive the reference thread gauge **90** into a threaded hole being inspected or onto a threaded stud being inspected.

The rotation device (electric motor) **160** rotates the reference thread gauge **90** in a second direction to drive the reference thread gauge **90** out of a threaded hole being inspected or off of a threaded stud being inspected.

The rotation device (electric motor) **160** may be a DC permanent magnet gear motor, which rotates the reference thread gauge **90** at a slow speed, such as, for example, 150 to 200 rpm, or other desired slow speed.

The thread gauge inspection apparatus **100** also includes a counter **150** that counts a number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction. The counter **150** may be an optical encoder coupled to the shaft/ratchet **185** or receiving member **180**.

The counter **150** may also be a mechanical encoder, an electrical encoder, or a magnetic encoder coupled to the shaft/ratchet **185** or receiving member **180**.

A ratchet monitoring device **187**, operatively connected to the shaft/ratchet **185**, monitors the ratcheting of the shaft/ratchet **185** as the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction.

When a predetermined limit of torque is exceeded, the shaft/ratchet **185** will begin to ratchet in that the rotation device (electric motor) **160** may continue to turn but the receiving member **180** or the reference thread gauge **90** will no longer turn. Upon sensing the ratcheting, the ratchet monitoring device **187** generates a signal indicating that the predetermined limit of torque has been exceeded. This signal is outputted to a controller **140**.

The controller **140** may be a processor, microprocessor, an application specific integrated circuit, electronic circuitry, and/or combination thereof. The controller **140**, is not, as is well known by those skilled in the art, purely software because software cannot by itself perform functions, but can only perform functions in conjunction with hardware.

The controller **140**, when the monitored torque exceeds the predetermined limit, causes the rotation device (electric motor) **160** to stop rotating the reference thread gauge **90** in the first direction.

The controller **140**, when the monitored torque exceeds the predetermined limit, also causes the counter **150** to stop counting the number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction. The controller **140** compares the count produced by the counter **150** with an inputted specific turn count.

The inputted specific turn count may be inputted through an input device as described with respect to FIG. **3** or **10**, or the inputted specific turn count may be inputted through a communication device **145**. The communication device **145** is in communication with communication device **245** of the thread gauge inspection control system **200** of FIG. **5**. The communication devices **145** and **245** communicate over communication channel **300**. Thus, the inputted specific turn count may be inputted through input device **250** of FIG. **5** and communicated to the thread gauge inspection apparatus **100**.

Communication channel **300** may be a wired channel, a fiber channel, a wireless channel, or an optical channel.

In another embodiment, the controller **140**, when the monitored torque exceeds the predetermined limit, causes the counter **150** to stop counting the number of turns the reference thread gauge **90** is rotated by the rotation device (electric motor) **160** in the first direction communicates the count produced by the counter **150** to the thread gauge inspection control system **200** of FIG. **5** for determining of inspection status.

The thread gauge inspection apparatus **100** may include an output device (not shown) to indicate, when the count produced by the counter **150** is equal to the inputted specific turn count, that the thread quality of the threaded hole or the threaded stud passed inspection. This output device may perform all the functions described with respect to the output device **30** of FIG. **3** or **10**.

The thread gauge inspection apparatus **100** may also include a gauge identification input device **125** to enable a technician to input the identification of the reference thread gauge **90**.

The gauge identification input device **125** may be a keypad for entering the numeric or alphanumeric identification of the reference thread gauge **90**.

The gauge identification input device **125** may also be a barcode reader for reading a barcode containing the identification of the reference thread gauge **90**. The barcode may be located on the reference thread gauge **90** or on a separate piece associated with the reference thread gauge **90**.

The gauge identification input device **125** may be a magnetic or RFID reader for acquiring the identification of the reference thread gauge **90**.

To identify the reference thread gauge **90**, the reference thread gauge **90** may include human-readable numeric and/or alphanumeric markings thereon for the technician to read and enter into the system. The reference thread gauge **90** may include a barcode thereon to provide identification, a RFID to provide identification, a magnetic strip to provide identification, and/or physical features (key), which can be mechanically detected to provide identification.

FIG. **12** illustrates a flowchart showing another embodiment of a thread gauge inspection process. As illustrated in FIG. **12**, a reference thread gauge begins rotating at step S**10**, the process of counting the number of turns that the reference thread gauge makes is started at step S**10**. The rotating of reference thread gauge and the count process continues until step S**120** determines (NO branch) that the torque on the reference thread gauge exceeds a predetermined limit, by sensing ratcheting in the driving of the reference thread gauge.

If step S**120** determines (YES branch) that the torque on the reference thread gauge exceeds a predetermined limit, the rotating of reference thread gauge and the count process are stopped at step S**30**.

At step S**40**, the count generated by the count process is compared with a specified count. The specified count can be inputted into the process before the inspection process is started. The specified count is the value used to determine the inspection status of the threads under test.

Optionally, at step S**35**, the rotation of the reference thread gauge can be reversed to disengage the reference thread gauge from the thread under test.

At step S**50**, it is determined if the count generated by the count process is within a predetermined range of the specified count.

If the count generated by the count process is within a predetermined range of the specified count (YES branch), step S**70** indicates that the thread under test passes inspection.

If the count generated by the count process is not within a predetermined range of the specified count (No branch), step S**60** indicates that the thread under test failed inspection.

As described above, a thread gauge inspection apparatus may include an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a threaded hole or a threaded stud; an output device to communicate a result of the inspection of the thread quality of the threaded hole or the threaded stud; a receiving member to hold a reference thread gauge; a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction to drive the reference thread gauge into the threaded hole being inspected or onto the threaded stud being inspected; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device in the first direction; a

torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction; and a controller operatively connected to the user input device, the rotation device, the counting device, and the torque monitoring device.

The controller, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction.

The controller, when the monitored torque exceeds the predetermined value, may cause the counting device to stop counting the number of turns the reference thread gauge is rotated by the rotation device in the first direction.

The controller, when the monitored torque exceeds the predetermined value, may compare the count produced by the counting device with the inputted specific turn count.

The controller, when the count produced by the counting device is equal to the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud passed inspection.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is greater than an upper boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud needs further consideration.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, or a magnetic encoder.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The controller, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction to drive the reference thread gauge out of the threaded hole being inspected or off of the threaded stud being inspected.

A thread gauge inspection apparatus may include a receiving member to hold a reference thread gauge; a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction to drive the reference thread gauge into the threaded hole being inspected or onto the threaded stud being inspected; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device in the first direction; and an output device to communicate, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The thread gauge inspection apparatus may further include a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction; and a controller operatively connected to the rotation device and the torque monitoring device, the controller, when the monitored torque exceeds a predetermined value, causing the rotation device to stop rotating the reference thread gauge in the first direction.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, or a magnetic encoder.

The controller, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction to drive the reference thread gauge out of the threaded hole being inspected or off of the threaded stud being inspected.

A thread gauge inspection system may include a reference thread gauge having unique identification; a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge, the thread gauge inspection apparatus acquiring the unique identification from the reference thread gauge; and a control system in operative communication with the thread gauge inspection apparatus.

The thread gauge inspection apparatus communicates the acquired unique identification from the reference thread gauge to the control system.

The control system determines the status of the identified reference thread gauge, the status of the identified reference thread gauge being either approved for inspecting the thread quality of a threaded hole or a threaded stud or not approved for inspecting the thread quality of the threaded hole or the threaded stud.

The control system communicates the determined status of the identified reference thread gauge to the thread gauge inspection apparatus.

The thread gauge inspection apparatus may include an input device to enable inputting the unique identification of the reference thread gauge.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the identified reference thread gauge and the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the threaded hole or the threaded stud.

The thread gauge inspection apparatus displays that the determined status of the identified reference thread gauge may not be approved for inspecting the thread quality of the threaded hole or the threaded stud when the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the threaded hole or the threaded stud.

The thread gauge inspection apparatus may include a controller, wherein the controller tracks a usage amount the identified reference thread gauge is used during an inspection process. The thread gauge inspection apparatus communicates the tracked usage amount of the identified reference thread gauge to the control system. The control system pro-

cesses the communicated the tracked usage amount to maintain a usage history of the identified reference thread gauge and determines the status of the identified reference thread gauge based upon the maintained usage history of the identified reference thread gauge.

The thread gauge inspection apparatus may include a rotation device to bi-directionally rotate the identified reference thread gauge, the rotation device rotating the identified reference thread gauge in a first direction to drive the identified reference thread gauge into the threaded hole being inspected or onto the threaded stud being inspected.

The thread gauge inspection apparatus may include a counting device to count a number of turns the identified reference thread gauge is rotated by the rotation device in the first direction, the count being the tracked usage amount that the thread gauge inspection apparatus communicates to the control system.

A thread gauge inspection system may include a reference thread gauge; a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge; and a control system in operative communication with the thread gauge inspection apparatus.

The thread gauge inspection apparatus may include an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a threaded hole or a threaded stud, an output device to communicate a result of the inspection of the thread quality of the threaded hole or the threaded stud, a receiving member to hold a reference thread gauge, a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction to drive the reference thread gauge into the threaded hole being inspected or onto the threaded stud being inspected, a counting device to count a number of turns the reference thread gauge is rotated by the rotation device in the first direction, a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction, and a controller operatively connected to the user input device, the rotation device, the counting device, and the torque monitoring device.

The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction. The controller, when the monitored torque exceeds the predetermined value, causes the counting device to stop counting the number of turns the reference thread gauge is rotated by the rotation device in the first direction.

The controller, when the monitored torque exceeds the predetermined value, compares the count produced by the counting device with the inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the threaded hole or the threaded stud passed inspection.

The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is equal to the inputted specific turn count, information indicating that the thread quality of the threaded hole or the threaded stud passed inspection.

The control system stores the information received from the thread gauge inspection apparatus.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus may communicate to the control system, when the count produced by the counting device is less than the inputted specific turn count, information indicating that the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is greater than the inputted specific turn count, information indicating that the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud passed inspection.

The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the threaded hole or the threaded stud passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the threaded hole or the threaded stud failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the threaded hole or the threaded stud failed inspection.

The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the threaded hole or the threaded stud failed inspection.

The reference thread gauge may have unique identification. The thread gauge inspection apparatus acquires the unique identification from the reference thread gauge and communicates the acquired unique identification from the reference thread gauge to the control system. The control system determines the status of the identified reference thread gauge, the status of the identified reference thread gauge being either approved for inspecting the thread quality of a threaded hole or a threaded stud or not approved for inspecting the thread quality of the threaded hole or the threaded stud. The control system communicates the determined status of the identified reference thread gauge to the thread gauge inspection apparatus.

The thread gauge inspection apparatus may include an input device to enable inputting the unique identification of the reference thread gauge.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the identified reference thread gauge and the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the threaded hole or the threaded stud.

The thread gauge inspection apparatus may display that the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the threaded hole or the threaded stud when the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the threaded hole or the threaded stud.

The thread gauge inspection apparatus may include a controller. The controller tracks a usage amount the identified reference thread gauge is used during an inspection process. The thread gauge inspection apparatus communicates the tracked usage amount of the identified reference thread gauge to the control system. The control system processes the communicated the tracked usage amount to maintain a usage history of the identified reference thread gauge. The control system determines the status of the identified reference thread gauge based upon the maintained usage history of the identified reference thread gauge.

The thread gauge inspection apparatus may include a rotation device to bi-directionally rotate the identified reference thread gauge, the rotation device rotating the identified reference thread gauge in a first direction to drive the identified reference thread gauge into the threaded hole being inspected or onto the threaded stud being inspected.

A thread gauge inspection apparatus may include a rotation device to bi-directionally rotate a reference thread gauge, the rotation device rotating the reference thread gauge in a first direction; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device; and an output device to communicate the counted number of turns the reference thread gauge is rotated by the rotation device as a result of an inspection of a thread quality of a machined thread.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the first direction, the first direction being a clockwise direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in a second direction, the second direction being a counter-clockwise direction.

The thread gauge inspection apparatus may include a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction, the torque monitoring device causing the rotation device to stop rotating the reference thread gauge in the first direction when the monitored torque exceeds a predetermined value.

The thread gauge inspection apparatus may include a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction; and a clutch mechanism operatively connected between the rotation device and the reference thread gauge, the torque monitoring device causing the clutch mechanism to disengage the reference thread gauge from the rotation device when the monitored torque exceeds a predetermined value.

The thread gauge inspection apparatus may include a ratcheting mechanism to cause the reference thread gauge to stop rotating in the first direction when a torque produced by the rotation device exceeds a predetermined value.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, and/or a magnetic encoder.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the second direction.

The torque monitoring device, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction.

The thread gauge inspection apparatus may include a receiving member to hold the reference thread gauge, the receiving member being operatively coupled to the rotation device.

The thread gauge inspection apparatus may include a receiving member to hold the reference thread gauge, the receiving member being operatively coupled to the clutch mechanism.

The thread gauge inspection apparatus may include a receiving member to hold the reference thread gauge, the receiving member being operatively coupled to the ratcheting mechanism.

The output device may visually indicate that the rotation device has stopped rotating the reference thread gauge in the first direction.

The output device may visually indicate that the ratcheting mechanism has caused the reference thread gauge to stop rotating.

The output device may audibly indicate that the rotation device has stopped rotating the reference thread gauge in the first direction.

The output device may audibly indicate that the ratcheting mechanism has caused the reference thread gauge to stop rotating.

A thread gauge inspection apparatus may include an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a machined thread; an output device to communicate a result of the inspection of the thread quality of the machined thread; a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device; a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction; and a controller operatively connected to the input device, the rotation device, the counting device, and the torque monitoring device. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction. The controller compares the count produced by the counting device with the inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than an upper boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread needs further consideration.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, and/or a magnetic encoder.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The counting device may count the number of turns the reference thread gauge is rotated by the rotation device in the first direction.

The controller, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction.

The counting device may count the number of turns the reference thread gauge is rotated by the rotation device in the second direction.

The counting device may count the number of turns the reference thread gauge is rotated by the rotation device in the first direction, the count produced by the counting device being equal to an average between the number of turns the reference thread gauge is rotated by the rotation device in the first direction and the number of turns the reference thread gauge is rotated by the rotation device in the second direction.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the second direction.

The thread gauge inspection apparatus may include a receiving member to hold the reference thread gauge, the receiving member being operatively coupled to the rotation device.

The thread gauge inspection apparatus may include a receiving member to hold the reference thread gauge; and a clutch mechanism operatively connected between the rotation device and the receiving member. The controller causes the clutch mechanism to disengage the receiving member from the rotation device when the monitored torque exceeds a predetermined value.

The output device may visually indicate that the rotation device has stopped rotating the reference thread gauge in the first direction.

The output device may audibly indicate that the rotation device has stopped rotating the reference thread gauge in the first direction.

A thread gauge inspection apparatus includes an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a machined thread; an output device to communicate a result of the inspection of the thread quality of the machined thread; a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction to drive the reference thread gauge into the machined thread being inspected; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device; a ratcheting mechanism to cause the reference thread gauge to stop rotating in the first direction when a torque produced by the rotation device exceeds a predetermined value; and a controller operatively connected to the input device, the rotation device, the counting device, and the torque monitoring device. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction. The controller compares the count produced by the counting device with the inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than an upper boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread needs further consideration.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, and/or a magnetic encoder.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The counting device may count the number of turns the reference thread gauge is rotated by the rotation device in the first direction.

The controller, when the ratcheting mechanism causes the reference thread gauge to stop rotating in the first direction, may cause the rotation device to rotate the reference thread gauge in a second direction.

The counting device may count the number of turns the reference thread gauge is rotated by the rotation device in the second direction.

The counting device may count the number of turns the reference thread gauge is rotated by the rotation device in the first direction, the count produced by the counting device

being equal to an average between the number of turns the reference thread gauge is rotated by the rotation device in the first direction and the number of turns the reference thread gauge is rotated by the rotation device in the second direction.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the second direction.

The thread gauge inspection apparatus may include a receiving member to hold the reference thread gauge, the receiving member being operatively coupled to the ratcheting mechanism.

The output device may visually indicate that the ratcheting mechanism has caused the reference thread gauge to stop rotating.

The output device may audibly indicate that the ratcheting mechanism has caused the reference thread gauge to stop rotating.

A thread gauge inspection apparatus includes an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a machined thread; an output device to communicate a result of the inspection of the thread quality of the machined thread; a receiving member to hold a reference thread gauge; a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device; a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction; and a controller operatively connected to the input device, the rotation device, the counting device, and the torque monitoring device. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction. The controller, when the monitored torque exceeds the predetermined value, compares the count produced by the counting device with the inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than an upper boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread needs further consideration.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, and/or a magnetic encoder.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The controller, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the second direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the first direction.

A thread gauge inspection apparatus includes a receiving member to hold a reference thread gauge; a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction; a counting device to count a number of turns the reference thread gauge is rotated by the rotation device; and an output device to communicate, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device in the first direction.

The thread gauge inspection apparatus may include a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction; and a controller operatively connected to the rotation device and the torque monitoring device. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction.

The counting device may be an optical encoder, a mechanical encoder, an electrical encoder, and/or a magnetic encoder.

The controller, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the second direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the first direction.

A thread gauge inspection system includes a reference thread gauge having unique identification; a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge; and a control system in operative communication with the thread gauge inspection apparatus. The control system determines the status of the identified reference thread gauge, the status of the identified reference thread gauge being either approved for inspecting the thread quality of a machined thread or not approved for inspecting the thread quality of the machined thread. The control system communicates the determined status of the identified reference thread gauge to the thread gauge inspection apparatus.

The thread gauge inspection apparatus may include an input device to enable inputting the unique identification of the reference thread gauge.

The control system may include an input device to enable inputting the unique identification of the reference thread gauge.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The control system may include an input device to enable reading of the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the identified reference thread gauge and the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may visually display that the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread when the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may audibly indicate that the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread when the control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may include a controller. The controller tracks a usage amount the identified reference thread gauge is used during an inspection process. The thread gauge inspection apparatus communicates the tracked usage amount of the identified reference thread gauge to the control system. The control system processes the communicated the tracked usage amount to maintain a usage history of the identified reference thread gauge. The control system determines the status of the identified reference thread gauge based upon the maintained usage history of the identified reference thread gauge.

The thread gauge inspection apparatus may include a rotation device to bi-directionally rotate the identified reference thread gauge. The thread gauge inspection apparatus may include a counting device to count a number of turns the identified reference thread gauge is rotated by the rotation device, the count being the tracked usage amount that the thread gauge inspection apparatus communicates to the control system.

The control system may wirelessly communicate with the thread gauge inspection apparatus.

The unique identification may be realized by a radio frequency identification device in the reference thread gauge.

The unique identification may be realized by optically scannable markings on the reference thread gauge.

The unique identification may include information identifying specifications of the reference thread gauge.

The control system may reset the status of the identified reference thread gauge to approved for inspecting after the identified reference thread gauge has been re-calibrated.

A thread gauge inspection system includes a reference thread gauge having unique identification; and a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge, the thread gauge inspection apparatus acquiring the unique identification from the reference thread gauge. The thread gauge inspection apparatus includes a controller to manage a status of the reference thread gauge and an output device. The controller receives the acquired unique identification from the reference thread gauge. The controller determines the status of the identified reference thread gauge, the status of the identified reference thread gauge being either approved for inspecting the thread quality of a machined thread or not approved for inspecting the thread quality of the machined thread. The output device indicates the determined status of the identified reference thread gauge.

The thread gauge inspection apparatus may include an input device to enable inputting the unique identification of the reference thread gauge.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the identified reference thread gauge and the controller determines the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may visually display that the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread when the controller determines the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may audibly indicate that the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread when the controller determines the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The controller may track a usage amount the identified reference thread gauge is used during an inspection process. The controller processes the tracked usage amount to maintain a usage history of the identified reference thread gauge. The controller determines the status of the identified reference thread gauge based upon the maintained usage history of the identified reference thread gauge.

The thread gauge inspection apparatus may include a rotation device to bi-directionally rotate the identified reference thread gauge. The thread gauge inspection apparatus includes a counting device to count a number of turns the identified reference thread gauge is rotated by the rotation device, the count being the tracked usage amount.

The unique identification may be realized by a radio frequency identification device in the reference thread gauge.

The unique identification may be realized by optically scannable markings on the reference thread gauge.

The unique identification may include information identifying specifications of the reference thread gauge.

The controller may reset the status of the identified reference thread gauge to approved for inspecting after the identified reference thread gauge has been re-calibrated.

A thread gauge inspection system includes a reference thread gauge having unique identification; a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge; and a control system in operative communication with the thread gauge inspection apparatus. the thread gauge inspection apparatus includes a rotation device to bi-directionally rotate a reference thread gauge, the rotation device rotating the reference thread gauge, a counting device to count a number of turns the reference thread gauge is rotated by the rotation device, and an output device to communicate the counted number of turns the reference thread gauge is rotated by the rotation device as a result of an inspection of a thread quality of a machined thread. The control system determines the status of the reference thread

gauge, the status of the reference thread gauge being either approved for inspecting the thread quality of a machined thread or not approved for inspecting the thread quality of the machined thread. The control system communicates the determined status of the reference thread gauge to the thread gauge inspection apparatus.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the first direction, the first direction being a clockwise direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in a second direction, the second direction being a counter-clockwise direction.

The thread gauge inspection apparatus may include a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction, the torque monitoring device causing the rotation device to stop rotating the reference thread gauge in the first direction when the monitored torque exceeds a predetermined value.

The thread gauge inspection apparatus may include a ratcheting mechanism to cause the reference thread gauge to stop rotating in the first direction when a torque produced by the rotation device exceeds a predetermined value.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device.

The torque monitoring device, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction.

The thread gauge inspection apparatus may include a controller. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction. The controller, when the monitored torque exceeds the predetermined value, cause the counting device to stop counting the number of turns the reference thread gauge is rotated by the rotation device. The controller, when the monitored torque exceeds the predetermined value, compares the count produced by the counting device with an inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the machined thread passed inspection.

The thread gauge inspection apparatus may communicate to the control system, when the count produced by the counting device is equal to the inputted specific turn count, information indicating that the thread quality of the machined thread passed inspection. The control system stores the information received from the thread gauge inspection apparatus.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is greater than the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread passed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The thread gauge inspection apparatus may include an input device to enable inputting the unique identification of the reference thread gauge.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The control system may include an input device to enable inputting the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the reference thread gauge and the control system communicates the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may display that the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread when the control system communicates the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may include a controller. The controller tracks a usage amount the reference thread gauge is used during an inspection process. The thread gauge inspection apparatus communicates the tracked usage amount of the reference thread gauge to the control system. The control system processes the communicated the tracked usage amount to maintain a usage history of the reference thread gauge. The control system determines the status of the reference thread gauge based upon the maintained usage history of the reference thread gauge.

The count may be the tracked usage amount that the thread gauge inspection apparatus communicates to the control system.

A thread gauge inspection system includes a reference thread gauge having unique identification; and a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge; and a control system in operative communication with the thread gauge inspection apparatus. The thread gauge inspection apparatus includes an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a machined thread, an output device to communicate a result of the inspection of the thread quality of the machined thread, a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction, a counting device to count a number of turns the reference thread gauge is rotated by the rotation device, a torque monitoring device to monitor the torque produced by the rotation device as the reference thread gauge is rotated by the rotation device in the first direction, and a controller operatively connected to the input device, the rotation device, the counting device, and the torque monitoring device. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge in the first direction. The controller compares the count produced by the counting device with the inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the machined thread passed inspection. The control system determines the status of the reference thread gauge, the status of the reference thread gauge being either approved for inspecting the thread quality of a machined thread or not approved for inspecting the thread quality of the machined thread. The control system communicates the determined status of the reference thread gauge to the thread gauge inspection apparatus.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the first direction, the first direction being a clockwise direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in a second direction, the second direction being a counter-clockwise direction.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device.

The torque monitoring device, when the monitored torque exceeds a predetermined value, may cause the rotation device to stop rotating the reference thread gauge in the first direction and to rotate the reference thread gauge in a second direction.

The thread gauge inspection apparatus may communicate to the control system, when the count produced by the counting device is equal to the inputted specific turn count, information indicating that the thread quality of the machined thread passed inspection. The control system stores the information received from the thread gauge inspection apparatus.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is greater than the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread passed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The control system may include an input device to enable inputting the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the reference thread gauge and the control system communicates the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may display that the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread when the control system communicates the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The controller may track a usage amount the reference thread gauge is used during an inspection process. The thread gauge inspection apparatus communicates the tracked usage amount of the reference thread gauge to the control system. The control system processes the communicated the tracked usage amount to maintain a usage history of the reference thread gauge. The control system determines the status of the reference thread gauge based upon the maintained usage history of the reference thread gauge.

The count may be the tracked usage amount that the thread gauge inspection apparatus communicates to the control system.

A thread gauge inspection system includes a reference thread gauge having unique identification; a thread gauge inspection apparatus having a receiving member to hold the reference thread gauge; and a control system in operative communication with the thread gauge inspection apparatus. The thread gauge inspection apparatus includes an input device to enable inputting of a specific turn count corresponding to inspection of a thread quality of a machined thread, an output device to communicate a result of the inspection of the thread quality of the machined thread, a rotation device to bi-directionally rotate the reference thread gauge, the rotation device rotating the reference thread gauge in a first direction to drive the reference thread gauge into the threaded hole being inspected or onto the threaded stud being inspected, a counting device to count a number of turns the reference thread gauge is rotated by the rotation device, a ratcheting mechanism to cause the reference thread gauge to stop rotating in the first direction when a torque produced by the rotation device exceeds a predetermined value, and a controller operatively connected to the input device, the rotation device, the counting device, and the torque monitoring device. The controller, when the monitored torque exceeds a predetermined value, causes the rotation device to stop rotating the reference thread gauge. The controller compares the count produced by the counting device with the inputted specific turn count. The controller, when the count produced by the counting device is equal to the inputted specific turn count, causes the output device to indicate the thread quality of the machined thread passed inspection. The control system determines the status of the reference thread gauge, the status of the reference thread gauge being either approved for inspecting the thread quality of a machined thread or not approved for inspecting the thread quality of the machined thread. The control system communicates the determined status of the reference thread gauge to the thread gauge inspection apparatus.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in the first direction, the first direction being a clockwise direction.

The counting device may count a number of turns the reference thread gauge is rotated by the rotation device in a second direction, the second direction being a counter-clockwise direction.

The output device may display, in real-time, the number of turns the reference thread gauge has been rotated by the rotation device.

The thread gauge inspection apparatus may communicate to the control system, when the count produced by the counting device is equal to the inputted specific turn count, information indicating that the thread quality of the machined thread passed inspection. The control system stores the information received from the thread gauge inspection apparatus.

The controller, when the count produced by the counting device is less than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is greater than the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is greater than the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread passed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is within a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread passed inspection.

The controller, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is outside a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The controller, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, may cause the output device to indicate the thread quality of the machined thread failed inspection. The thread gauge inspection apparatus communicates to the control system, when the count produced by the counting device is less than a lower boundary value of a predetermined range, the predetermined range including the inputted specific turn count, information indicating that the thread quality of the machined thread failed inspection.

The unique identification of the reference thread gauge may be machine readable.

The thread gauge inspection apparatus may include an input device to enable reading of the unique identification of the reference thread gauge.

The control system may include an input device to enable inputting the unique identification of the reference thread gauge.

The thread gauge inspection apparatus may enter into an inoperative state when the receiving member holds the reference thread gauge and the control system communicates the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The thread gauge inspection apparatus may display that the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread when the control system communicates the determined status of the reference thread gauge is not approved for inspecting the thread quality of the machined thread.

The controller may track a usage amount the reference thread gauge is used during an inspection process. The thread gauge inspection apparatus communicates the tracked usage amount of the reference thread gauge to the control system. The control system processes the communicated the tracked usage amount to maintain a usage history of the reference thread gauge. The control system determines the status of the reference thread gauge based upon the maintained usage history of the reference thread gauge.

The count may be the tracked usage amount that the thread gauge inspection apparatus communicates to the control system.

It will be appreciated that various of the above-disclosed and other features and functions, or alternatives thereof, may

be desirably combined into many other different systems or applications. Also that various presently unforeseen or unanticipated alternatives, modifications, variations or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What is claimed is:

1. A thread gauge inspection system, comprising:

a reference thread gauge having unique identification;

a thread gauge inspection apparatus having a receiving member to hold said reference thread gauge; and

a control system in operative communication with said thread gauge inspection apparatus;

said control system determining the status of the identified reference thread gauge, the status of the identified reference thread gauge being either approved for inspecting the thread quality of a machined thread or not approved for inspecting the thread quality of the machined thread;

said control system communicating the determined status of the identified reference thread gauge to said thread gauge inspection apparatus.

2. The thread gauge inspection system, as claimed in claim **1**, wherein said thread gauge inspection apparatus includes an input device to enable inputting the unique identification of said reference thread gauge.

3. The thread gauge inspection system, as claimed in claim **1**, wherein said control system includes an input device to enable inputting the unique identification of said reference thread gauge.

4. The thread gauge inspection system, as claimed in claim **1**, wherein the unique identification of said reference thread gauge is machine readable.

5. The thread gauge inspection system, as claimed in claim **4**, wherein said thread gauge inspection apparatus includes an input device to enable reading of the unique identification of said reference thread gauge.

6. The thread gauge inspection system, as claimed in claim **4**, wherein said control system includes an input device to enable reading of the unique identification of said reference thread gauge.

7. The thread gauge inspection system, as claimed in claim **1**, wherein said thread gauge inspection apparatus enters into an inoperative state when said receiving member holds said identified reference thread gauge and said control system communicates the determined status of said identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

8. The thread gauge inspection system, as claimed in claim **1**, wherein said thread gauge inspection apparatus visually displays that the determined status of said identified reference thread gauge is not approved for inspecting the thread quality of the machined thread when said control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

9. The thread gauge inspection system, as claimed in claim **1**, wherein said thread gauge inspection apparatus audibly indicates that the determined status of said identified reference thread gauge is not approved for inspecting the thread quality of the machined thread when said control system communicates the determined status of the identified reference thread gauge is not approved for inspecting the thread quality of the machined thread.

10. The thread gauge inspection system, as claimed in claim **1**, wherein said thread gauge inspection apparatus includes a controller;

said controller tracking a usage amount said identified reference thread gauge is used during an inspection process;

said thread gauge inspection apparatus communicating the tracked usage amount of said identified reference thread gauge to said control system;

said control system processing the communicated the tracked usage amount to maintain a usage history of said identified reference thread gauge;

said control system determining the status of said identified reference thread gauge based upon the maintained usage history of said identified reference thread gauge.

11. The thread gauge inspection system, as claimed in claim **10**, wherein said thread gauge inspection apparatus includes a rotation device to bi-directionally rotate said identified reference thread gauge;

said thread gauge inspection apparatus including a counting device to count a number of turns said identified reference thread gauge is rotated by said rotation device, the count being the tracked usage amount that said thread gauge inspection apparatus communicates to said control system.

12. The thread gauge inspection system, as claimed in claim **1**, wherein said control system wirelessly communicates with said thread gauge inspection apparatus.

13. The thread gauge inspection system, as claimed in claim **1**, wherein said unique identification is realized by a radio frequency identification device in said reference thread gauge.

14. The thread gauge inspection system, as claimed in claim **1**, wherein said unique identification is realized by optically scannable markings on said reference thread gauge.

15. The thread gauge inspection system, as claimed in claim **1**, wherein said unique identification includes information identifying specifications of said reference thread gauge.

16. The thread gauge inspection system, as claimed in claim **1**, wherein said control system resets the status of the identified reference thread gauge to approved for inspecting after said identified reference thread gauge has been re-calibrated.

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